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T.R.E. MEMORANDUM

No. 159

A METHOD OF MAKING TAGLESS SOLDER CONNECTIONS TO INSULATORS
AND CARBON FILM RESISTORS FOR PRINTED WIRING
TECHNIQUES

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UNCLASSIFIEDA METHOD OF MAKING TAGLESS SOLDER CONNECTIONS TO INSULATORS
AND CARBON FILM RESISTORS FOR PRINTED WIRING
TECHNIQUES(1) SUMMARY

In parallel with the development of suitable flat resistors for printed circuit technique it has been necessary to find a method of making electrode connections directly to these carbon film resistors. It must be possible to solder to these electrodes. A satisfactory method has been developed and this has also been found useful in making solder connections to insulating strips, tagless groupboards and formers used for winding potentiometer elements.

(2) PROCESSES INVESTIGATED

The following methods of providing metallic contact to carbon film resistors have been tried and the results tabulated.

<u>Method</u>	<u>Results</u>
1. Chemical reduction of metallic salt to form thin metal film.	Film not strongly adherent. Will not solder. Suitable as temporary contact.
2. Thickening of above film by electrolytic action.	Reduced metal film adhered to electrolytic film and both peeled off.
3. Spraying of copper, zinc and cadmium.	Impossible to solder. Suitable as pressure contact connection.
4. Copper foil bonding	Connection uncertain and cumbersome to apply.
5. Formation of silver or other metal foil by hot pressing powdered metal.	Not adherent to carbon film.
6. Proprietary silver inks.	High resistance connection. Impossible to solder.
7. Metallic dust mixed in synthetic resin to form a paste.	High resistance contact. Not possible to solder.
8. Metallic dust hot die-pressed on semi-polymerised synthetic resin.	Satisfactory connection and suitable for soldering.

This last method has been found to be completely satisfactory when carefully carried out and is described in detail below.

(3) DESCRIPTION OF THE SUCCESSFUL PROCESS

The process is as follows: The areas where conductor lines are required are coated with a synthetic resin cement by brushing for simple lines, or by silk screen stencilling, offset printing or spraying through a mask for more complicated circuits. The film of cement must be made as thin as possible.

The metallic powder (precipitated silver has been most successful) is dusted by means of a fine mesh sieve over the circuit element to a sufficient thickness to saturate the cement. The excess powder is tapped off and the plate placed for about 10 minutes in an oven operating at about 80°C. This drives off most of the volatile solvent. The circuit element is then withdrawn from the oven and placed in a heated press, preferably using a heated circuit die, the temperature and pressure depending on the base material and the synthetic resin being used. The circuit element is withdrawn from the press when the resin is fully cured. The resin used for the experiments is Bakelite Cement J.11185, heated to 140°C. for about half an hour; but with higher pressure under heated dies, shorter times have been found satisfactory, and the finish and adherence improved.

The heat and pressure cause the metallic particles to penetrate the resin and to embed themselves in the base material, at the same time providing a principally metallic outer layer suitable for soldering. In order to ascertain the reliability of the connection to the carbon film and the resistance per unit square, specimen sheets have been measured before and after the deposition of the electrodes. The measurement also provided an indication of the change in resistance of the film due to the load and pressure. The change in ohms per unit square should be less than five per cent providing that reasonable care is taken in the process.

Figure 1 explains the adherence of the metallic coating to the base layer. In figure 1 (a) it will be seen that there is a resin-carbon phase between the metal-resin and carbon-resin phases. This is due to the penetration to the carbon-resin layer of some of the thin film of circuit line resin. The adherence of the metallic film is due to the presence of this transitional phase. The apparent disadvantage of such a mechanism is that a high resistive layer is interposed between the conductor and the resistor. Experiment has shown that, in resistors with up to 0.2 inch between electrodes, the increase in resistance is less than 5% from all causes involved in the process. The current density at the electrodes is not increased beyond that of the resistor area since all parts under the electrodes are at the same potential. On the other hand, Figure 1(b) shows how the chemical reduction, electrolytic and die stamped metal foil process fail to secure adhesion. Figure 1 (c) demonstrates the high resistance and difficulty of soldering the metal-resin paste films. When attempting to solder such a film, the resin melts and flows between the metal and the solder connection.

(4) METHODS OF OUTLINING ELECTRODE AREAS

As already mentioned, for simple test strips, the synthetic resin film can be deposited by brush or rubber roller, but for more complex circuits or areas it is necessary to use a mask or stencil. Experimental work has been carried out using silk screens and satisfactory results achieved. It is necessary to provide a stencil that is not affected by the solvents used to clear the synthetic resin off the silk screen. This can be accomplished by protecting the masked areas of the stencil with another synthetic resin which is insoluble in the solvents of the circuit line resin.

A second circuit-making method is to spray the thin resin film through an open stencil. For laboratory purposes this is more difficult to cut than a silk screen stencil but would probably be more suitable for automatic operation. Other methods of applying the resin suggest themselves, such as off-set and die printing or photo-mechanical means.

Apart from the use of the metallic dusting technique for printed circuits and resistors, it is suggested that the ~~pattern~~ ^{plate} would be useful for providing solderable contacts on the ends of wire-wound potentiometers and variable resistance formers, especially where a flat strip of resin impregnated paper or fabric is used. With toroidal formers, special jigs would be required to prevent the operation of pressing, brushing the former. A further use for the process is to provide solder connections to components, so dispensing with eyelets and tags. Applications are illustrated in Figures 2 and 3.

CONCLUSIONS

The process has been successfully used on poor quality synthetic resin paper bonded material, fabric based materials, asbestos loaded and good quality pure resin boards. It is the only method among those tried in which successful soldered joints have been made to the carbon-resin coated fabric base material that it is intended to use for aspect ratio resistors (see T.R.E. Technical Note No.43 : Aspect Ratio Resistors for Printed and Deposited Circuits).

ILLUSTRATIONS

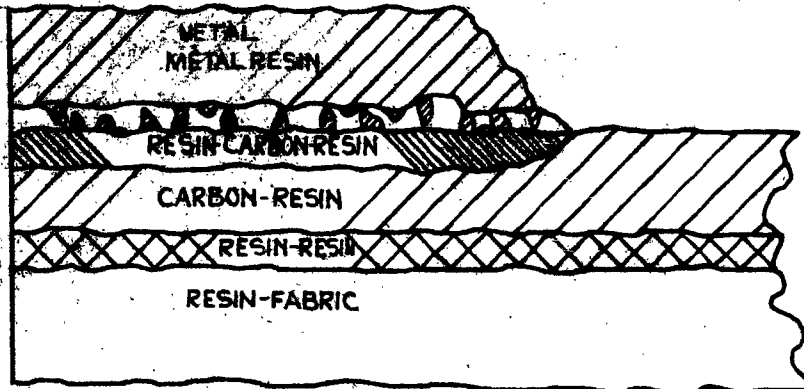
- Figure 1. Phases in Contact Mechanism - RTR11/6047
2. Photograph of Examples. - TRE - A.5796
3. Application of Tagless Solder Connections - RTR/6066.

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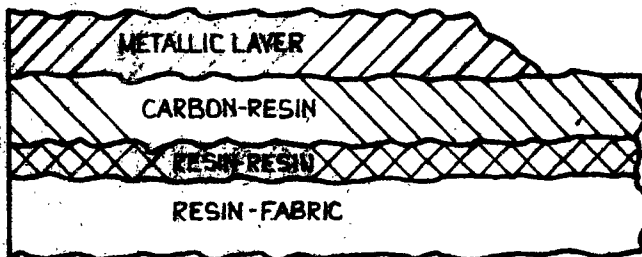
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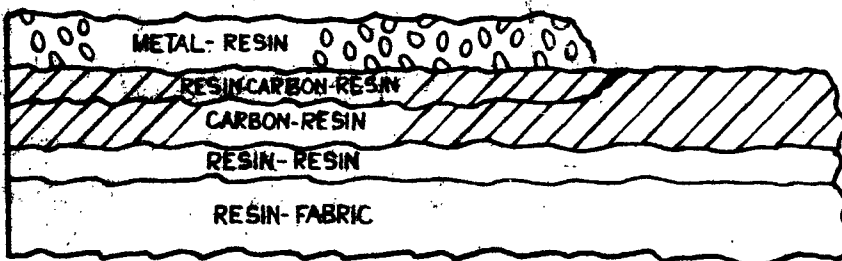
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(1a) POWDERED METAL ON RESIN METHOD



(1b) SPRAYED
METAL ELECTRODES

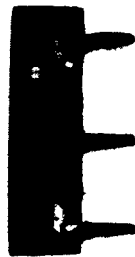


(1c) POWDERED METAL IN RESIN

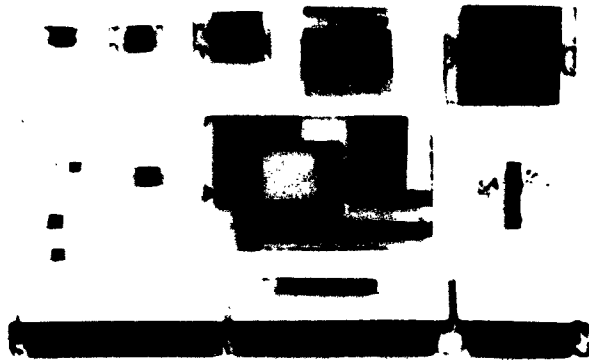
PHASES IN CONTACT MECHANISM.



POTENTIOMETER
FORMERS



TAGLESS GROUP
BOARD



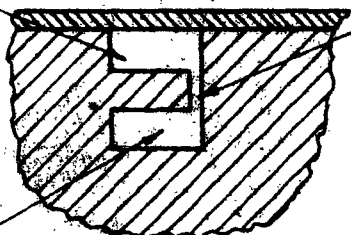
CARBON FILM
RESISTORS

METALLIZED SYNTHETIC
RESIN BORED LAMINATES

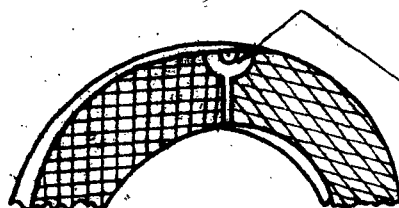
SILVER AREA
FOR CONNECTION
TO CIRCUIT

NARROW SILVER
LINE TO REDUCE
THERMAL
CONDUCTION
WHEN SOLDERING.

SILVER AREA
FOR COMPONENT
CONTACT.



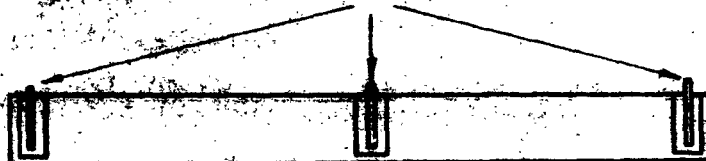
3a. PRINTED METAL CONTACT FOR TAGLESS GROUP BOARDS AND COIL FORMERS.



METALLIZED CONTACT
AND TRACK DIVIDING
LINE.

3b. METHOD OF PROVIDING SOLDERED TAPPING POINTS ON CARBON FILM POTENTIOMETERS.

WIRES SOLDERED TO SILVERED AREAS ON
INSULATING STRIP. END AND CENTRE TAPS
CAN BE TWISTED AROUND PEG THIS PROVIDED.



3c. METHOD OF MAKING CONNECTIONS TO POTENTIOMETER FORMERS, INCLUDING SIMPLIFIED TAPPING ARRANGEMENT.

FIG. 3.
APPLICATIONS OF TAGLESS SOLDER CONNECTIONS.



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